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PHOTONICS SOLUTIONS FOR QUANTUM SPACE COMMUNICATION

Nicephore NICOLAS- Deputy Sales Director - Photonics

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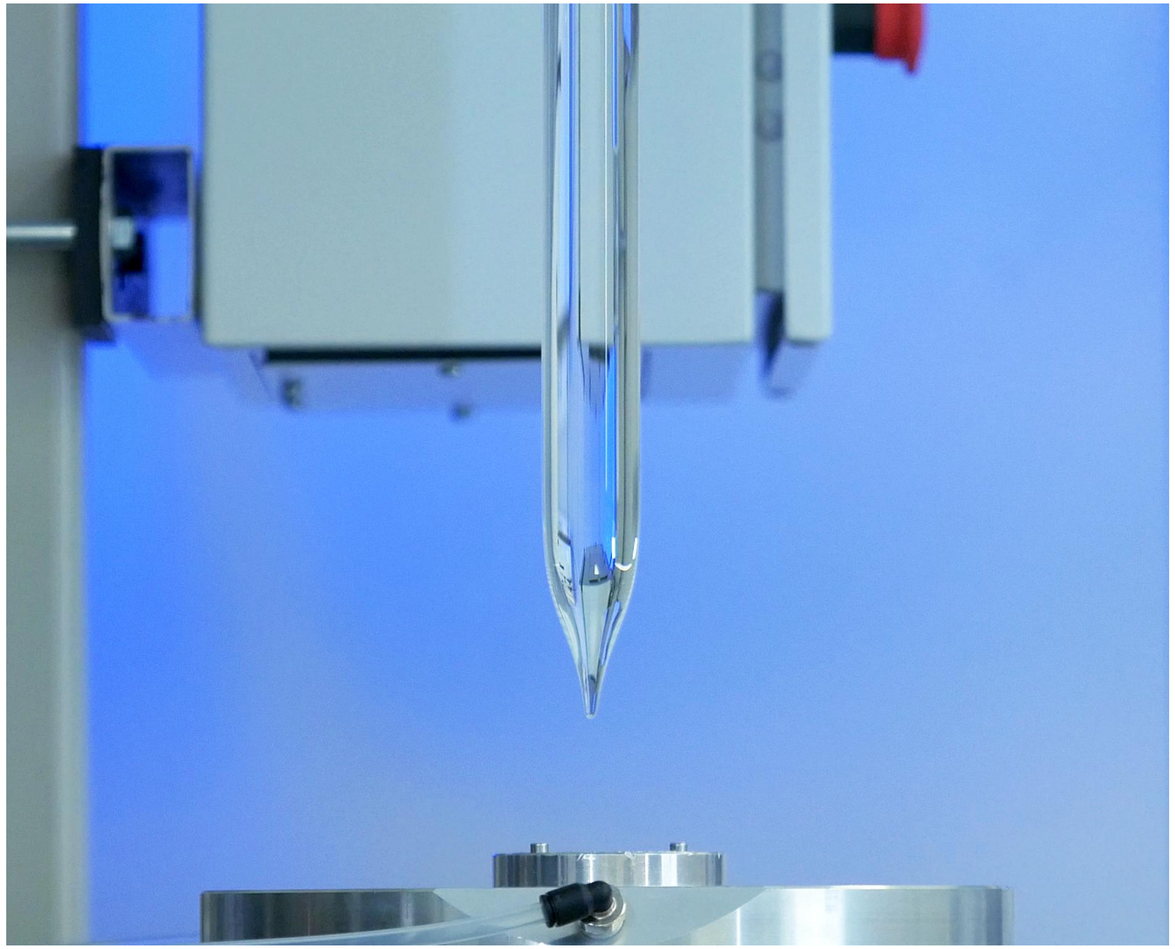


18/10/2022: ECA group and iXblue join forces and become exail

A global industrial high-tech champion

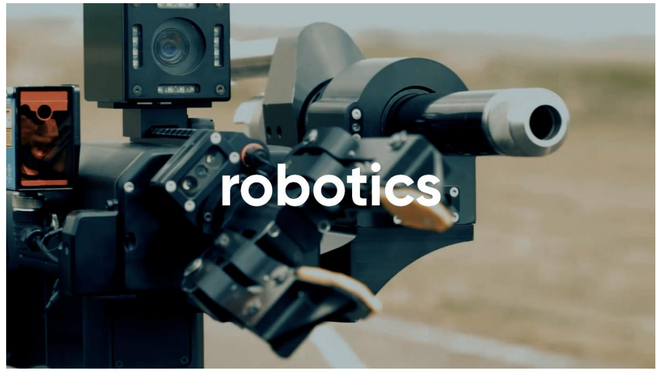
1500+
EMPLOYEES

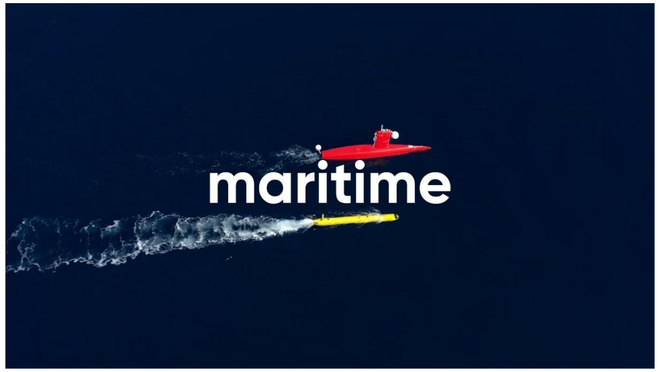
80%
OF TURNOVER ACHIEVED ABROAD

20%
OF TURNOVER REINVESTED EACH YEAR IN R&D

250+
MILLION EUROS OF TURNOVER

Cutting-edge technologies





Photonics solutions, from components to instruments

Scalable technologies to address a full range of applications

› Components
(COTS, Space grade)

$LiNbO_3$ Phase, Amplitude, IQ Modulators

Modulators Matching components (RF Amplifier, Low Noise Electronic)

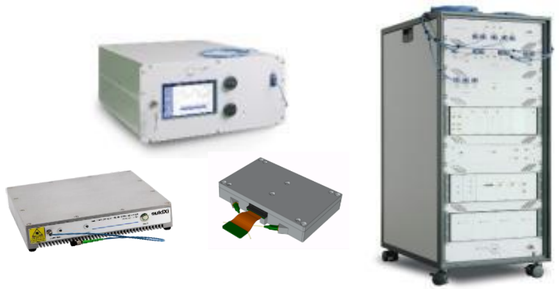
Fibers and fiber solutions (Specialty Fiber, FBG, polarisers…)

› Turn-Key devices and systems

µoptics and passive optics integration

Fiber optic Gyroscope, accelerometer

Lasers (Narrow-linewidth, high-power)
Optical Low Noise & Power amplifiers



› Instruments

Absolute Quantum Gravimeter

Cold atom frequency metrology

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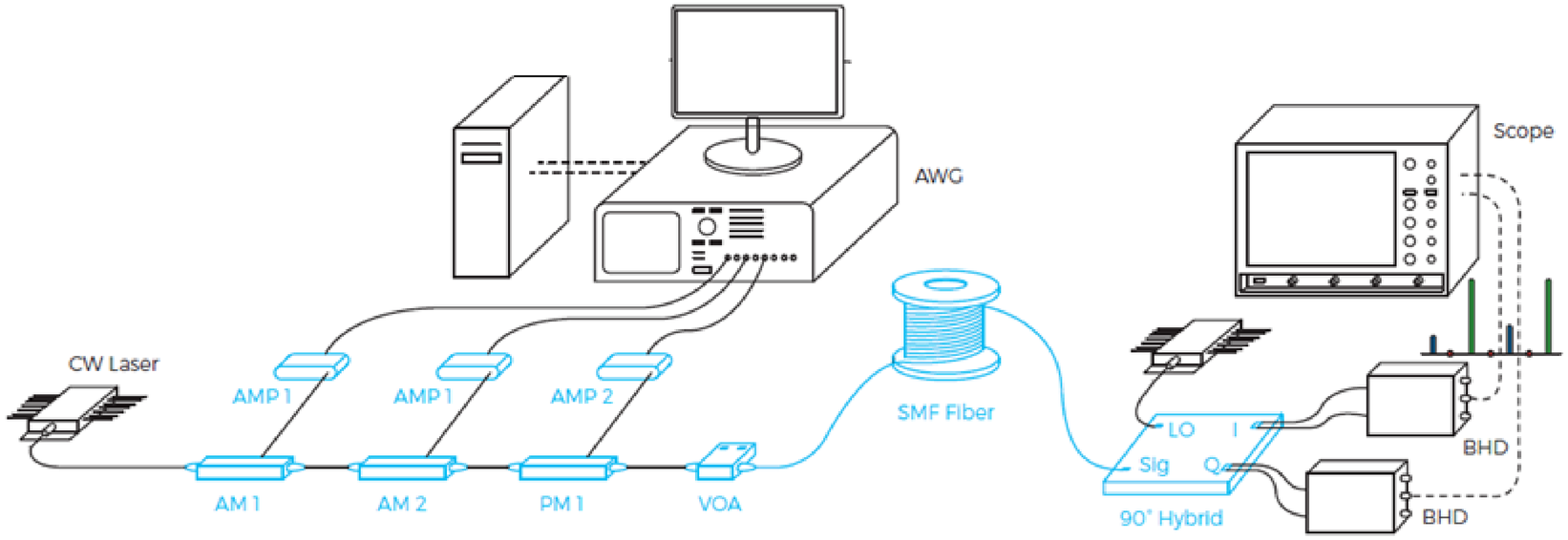
Quantum Key Distribution - QKD

A Continuous Variable QKD – Set-up example

Information encoded in the amplitude and phase of laser pulses.
Using standard telecom componenets: laser, modulators and coherent reiceivers

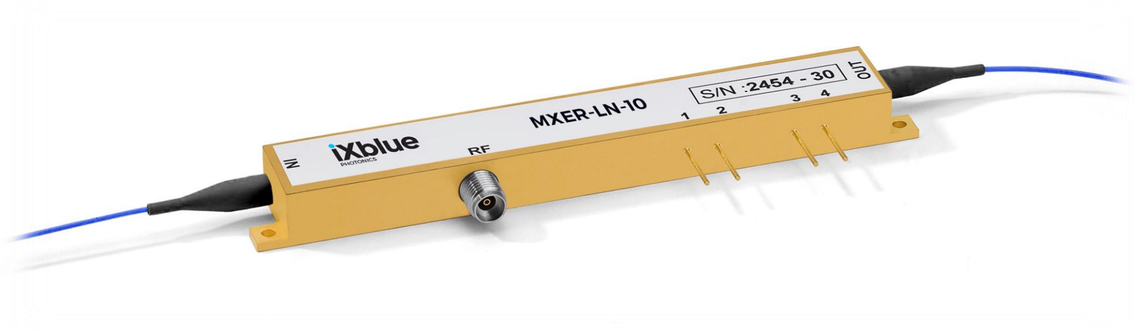


- **Amplitude Modulator 1**
  - To generate very short pulse
- **Phase Modulator**
  - To randomize the optical Pulse
- **90° Optical Hybrid**
  - For coherent detection
- **Amplitude Modulator 2**
  - To randomize the optical pulse amplitude
- **CW Low linewidth Laser**
  - Local Oscillator

Quantum Key Distribution –QKD

$LiNbO_3$ Amplitude modulators

- **One specific amplitude Modulator per wavelength**
- **iXblue « Magic Junction » patent to ensure Low Insertion Loss and High Extinction Ratio**
- **Low DC drift based on a specific (RF and DC electrodes separated) and X-cut design**
- **Space qualified**



λ	850 nm	1310 nm	1550 nm
Modulator	NIR-MX800-LN-10 NIR-MX800-LN-20	MXER1300-LN-10	MXER-LN-10
Insertion loss (Typ)	< 5,5 dB (4,5 dB)	< 4.5 dB (3,5 dB)	< 4.5 dB (3,5 dB)
Extinction Ratio (Typ)	> 20 dB (25 dB)	> 26 dB (30 dB)	> 30 dB (33 dB)
Rise / Fall times	NIR-MX800-LN-10: < 50 ps NIR-MX800-LN-20: < 20 ps	< 20 ps	< 20 ps
Optical power handling	> 60 mW	> 16 mW	100 mW

Quantum Key Distribution –QKD

$LiNbO_3$ Phase modulators

- **One specific Phase Modulator per wavelength**
- **Low insertion Modulator option**
- **Low driving voltage and low S11 for higher modulation efficiency**
- **DC coupled versions for RAM and pyroelectrical effect mitigations**
- **Space qualified**

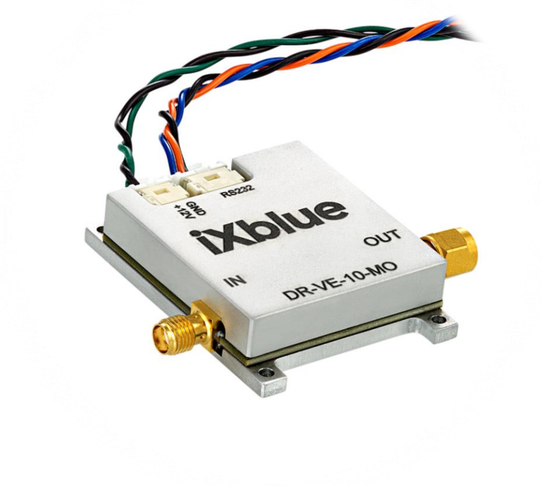
λ	850 nm	1310 nm	1550 nm
Modulator	NIR-MPX800-LN-10 NIR-MPX800-LN-20	MPZ1300-LN-10	MPZ-LN-01 MPZ-LN-10
Insertion loss (Typ)	< 3,5 dB (2,5 dB)	< 5 dB (3 dB)	MPZ-LN-01: < 2,5 dB (3,5 dB) MPZ-LN-10: < 2 dB (2 dB)
Operating bandwidth	NIR-MPX800-LN-10: 12 - 14 GHz NIR-MPX800-LN-20: 16 – 18 GHz	> 15 GHz	MPZ-LN-01: 4 – 5 GHz MPZ-LN-10: > 15 - 16 GHz
Vπ Vs Frequency	NIR-MPX800-LN-10 @10 GHz ~ 5 V NIR-MPX800-LN-20 @14 GHz ~ 5,5 V	MPZ-LN-10 @10 GHz ~ 4 V / @16 GHz ~ 5 V	MPZ-LN-01 @1 GHz ~ 3 V / @4 GHz ~ 5 V MPZ-LN-10 @10 GHz ~ 5 V / @16 GHz ~ 6 V

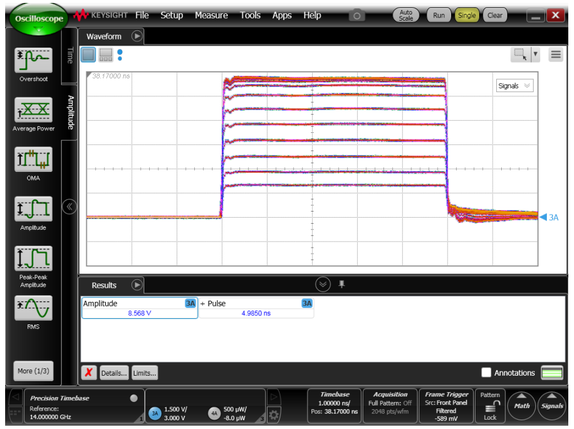
Quantum Key Distribution –QKD

Linear and Limiting Amplifier RF amplifiers

The DR-VE-10-MO :

- **Versatile modulator driver: Limiting (Pulse) and Linear (multi-level) RF amplifier**
- **Integrated µcontroller and embeds the latest microwave chips generation**
- **Space version: TRL6**





Specifications	DR-VE-10-MO
Bandwidth	> 14 GHz
Output voltage swing	> 9 Vpp
Gain	> 30 dB
Rise a fall times	20 ps

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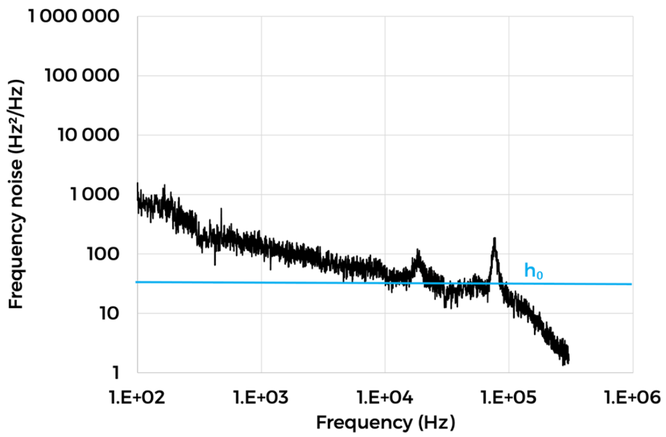
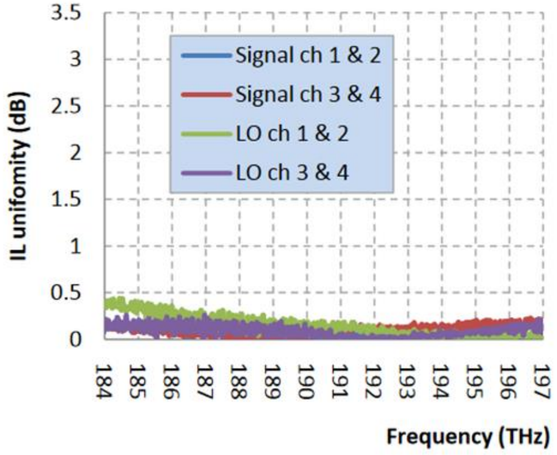
Quantum Key Distribution –QKD

Additional Optical Components for efficient coherent transmission and encryption

- **IXF-LAB-LAZ-NL: Ultra-narrow Fiber based light source as seeder or local Oscillator**
  - Rx side: used as super seeder for modulators
  - Tx side: used as Local Oscillator for efficient coherent reiception
  - Based on iXblue Erbium Fibers and FBG inscription;
  - 0,1 khz linewidth, low Phase noise 40 mW, PM
  - COTS, space version possible.



- **COH090: 90° Optical Hybrid**
  - Rx side: extract phase and amplitude by performing four 90° phase stepped interferences between the signal and a local Oscillator
  - Wide operating wavelength range, excellent dual uniformities and low insertion loss



- **Other components for custom encryption design**
  - Delay Line Interferometer, splitters, isolators, attenuators, filters, multiplexers…

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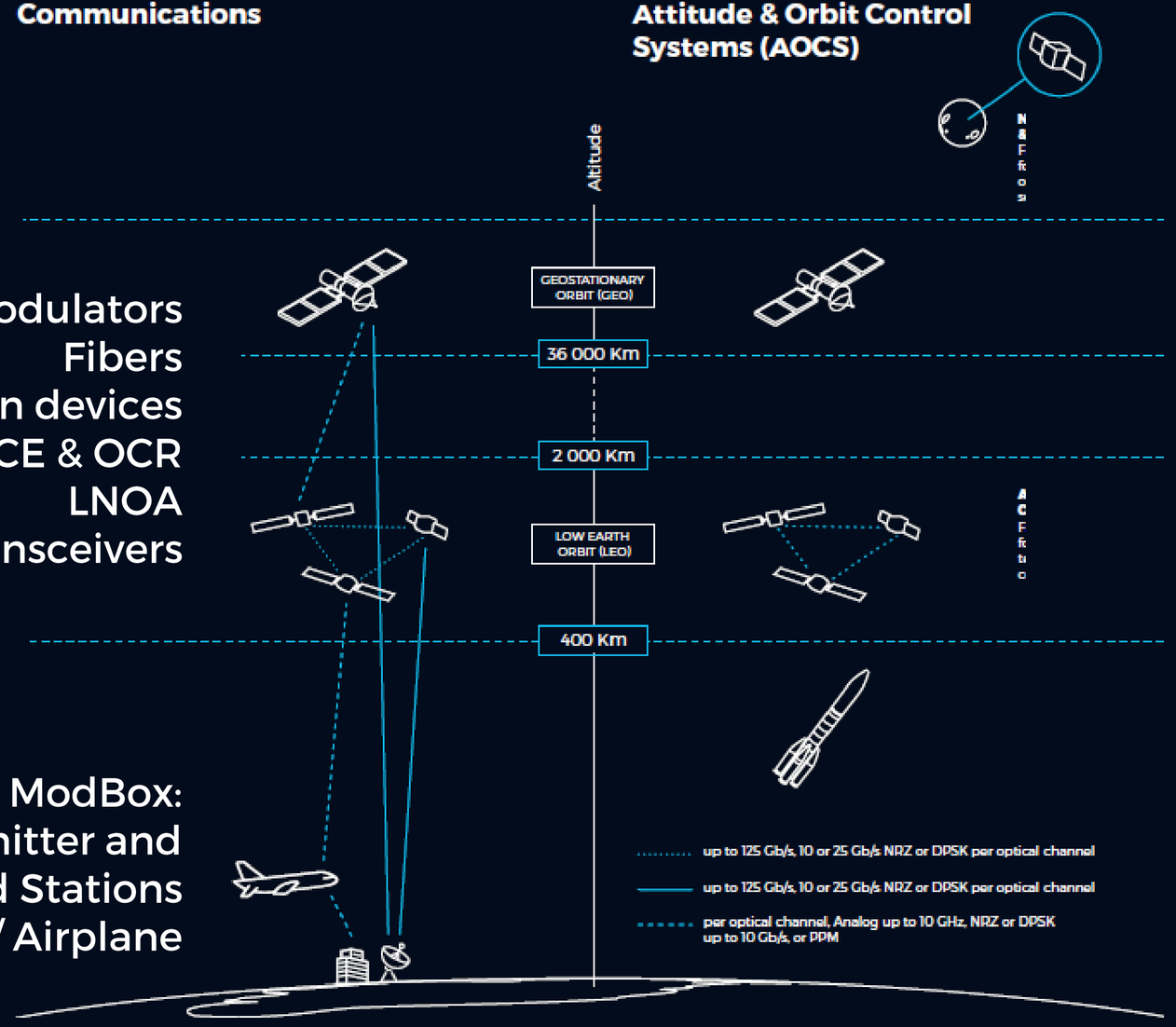
iXblue flight proven optical solutions for space applications

Laser Communications

Navigation, Attitude & Orbit Control Systems (AOCS)

Modulators
Fibers
Micro-optics integration devices
OCE & OCR
LNOA
Transceivers

ModBox:
Reference transmitter and receiver for Ground Stations / Airplane



Astrix

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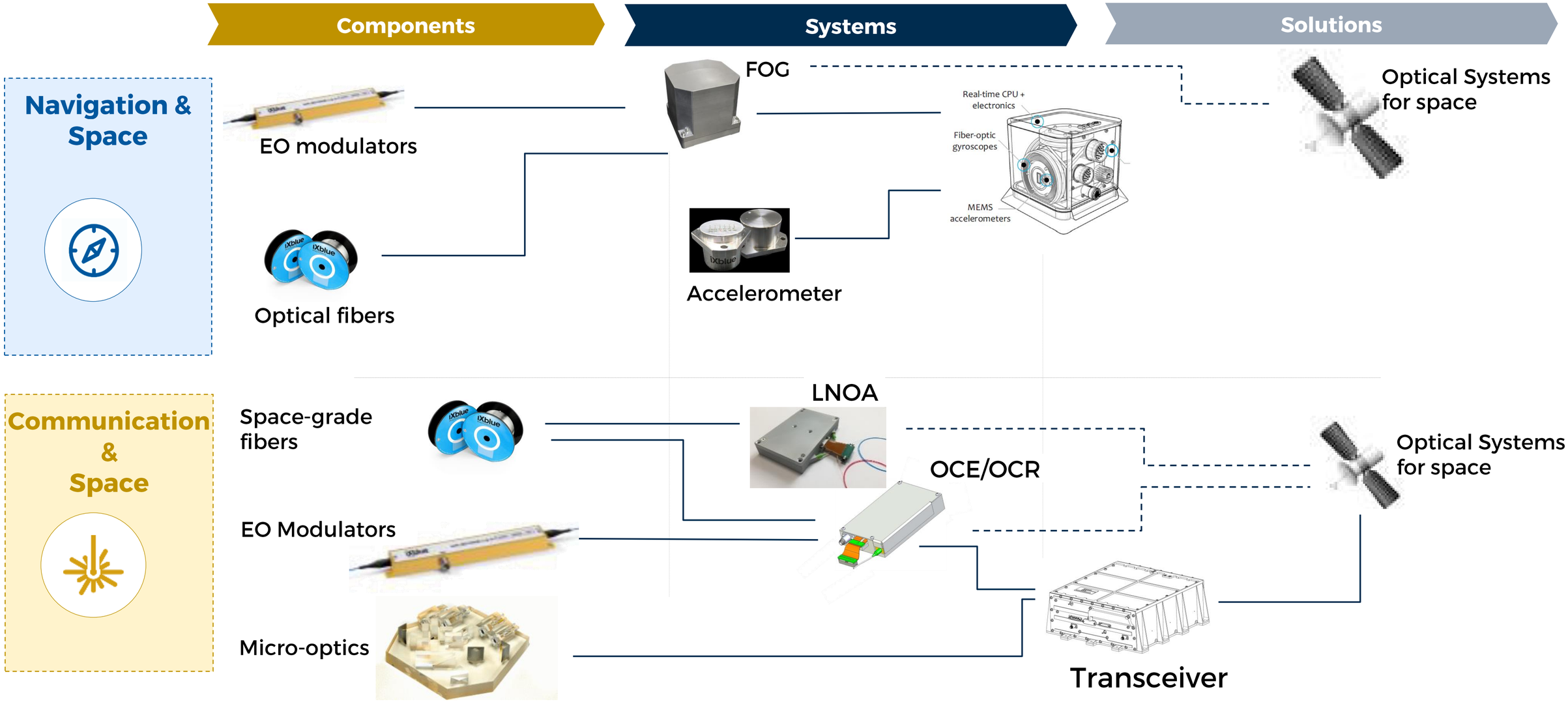
From components to complete systems



Conclusion

What can we bring to quantum space com?

- Key Optical Components for efficient QKD : Phase and Amplitude modulators, low linewidth lasers, 90° optical hybrid, delay line interferomer…
- Space grade versions are available as COTS or as customs. Please consult us.
- Industrial capability to integrate space grade systems.

What can you do for us?

- Challenge us with your components or integration systems needs ☺
- Always looking for additional components : Photodiodes, balanced photodiodes, space grade electronics…

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